Table 6-13.—Steps for Making Amplitude Measurements

STEP	ACTION
1	Connect probe or cable (depending on the measurement) to Channel 1 connector. If using a probe make sure that it is compensated, and ensure all variable (CAL) controls are in their detent positions.
2	Set VERTICAL MODE switch to Channel 1 and the Channel 1 input-coupling switch to AC. The TRIGGER MODE switch should be set to NORM for normal triggering, and the TRIGGER SOURCE switch set to Channel 1.
3	Connect the signal to be measured via the probe or cable and adjust the TRIGGER LEVEL control to obtain a stable trace while adjusting the Channel 1 VOLTS/DIV switch until the signal is about 5 divisions high. Now adjust the SEC/DIV switch until about one cycle of the waveform is displayed on the screen.
4	Use the Channel 1 POSITION control to move the waveform so that its bottom is aligned with a convenient horizontal graticule line that allows you to approximately center the waveform vertically. Use the HORIZONTAL COARSE POSITION control to move the signal so that either the top or the bottom of the cycle intersects the center graticule line.
5	Now count the major and minor divisions up the center vertical graticule line and multiply by VOLTS/DIV setting. The result is the amplitude of the signal.

the Model 2246 oscilloscope. Refer to figure 6-13 when reviewing tables 6-13 and 6-14.

Q6-29. What is the primary function of an oscilloscope?

Q6-30. Name the three axes of a typical oscilloscope?

Q6-31. What do the three axes of an oscilloscope represent?

Q6-32. Identify at least four items of information that an oscilloscope can tell you about a signal?

Q6-33. All electronic equipment can be classified into one of what two information categories?

Q6-34. On an analog oscilloscope, what happens when the signal being analyzed exceeds the frequency range of the oscilloscope?

Q6-35. What are the three kinds of oscilloscopes?

Table 6-14.—Steps for Making Time and Frequency Measurements

STEP	ACTION
1	Connect probe or cable (depending on the measurement) to Channel 1 connector. If using a probe make sure that it is compensated, and ensure all variable (CAL) controls are in their detent positions.
2	Set VERTICAL MODE switch to Channel 1 and the Channel 1 input-coupling switch to AC. The TRIGGER MODE switch should be set to NORM for normal triggering, and the TRIGGER SOURCE switch set to Channel 1.
3	Connect the signal to be measured via the probe or cable and adjust the TRIGGER LEVEL control to obtain a stable trace while adjusting the Channel 1 VOLTS/DIV switch until the signal is about 5 divisions high. Now adjust the SEC/DIV switch until about one cycle of the waveform is displayed on the screen.
4	Use the Channel 1 POSITION control to move the waveform so that its bottom is aligned with a convenient horizontal graticule line that allows you to approximately center the waveform vertically.
5	Now with the HORIZONTAL COURSE and FINE POSITION controls, position a rising edge of the signal being measured with the second graticule line from the left side of the screen. Use the HORIZONTAL COARSE POSITION control to move the signal so that either the top or the bottom of the cycle intersects the center graticule line.

Q6-36. What determines the frequency range of a digitizing oscilloscope?

Q6-37. What advantage does a digitizing storage oscilloscope have over other kinds of oscilloscopes?

Q6-38. When an electrical signal is measured with an analog oscilloscope, what section of the oscilloscope controls the attenuation or amplification of the signal being analyzed?

Q6-39. What section of an analog oscilloscope is used to stabilize a repeating signal?

Q6-40. What type of oscilloscope uses serial processing?

Q6-41. (True or false) The amplitude of a signal is best measured when the signal covers most of the oscilloscope screen horizontally.

Q6-42. (True or false) Time measurements of a signal are best measured when the signal covers most of the oscilloscope screen horizontally.

SPECTRUM ANALYZER

When a wave (called a carrier) is modulated by varying the amplitude, frequency, or phase so it varies in step with another wave (called a modulating wave), the resulting wave contains many frequencies. The original carrier is present together with two groups of new frequencies (sideband components). One group of sidebands is displaced in frequency below the carrier. The other group is displaced above the carrier. The distribution of these frequencies can be shown on a graph of amplitude plotted on the vertical or (X-axis) against frequency plotted on the horizontal or (Y-axis) as shown below in figure 6-14. The overall pattern of this display indicates the proportion of power present in the various frequencies within the spectrum of the wave (fundamental frequency with sideband frequencies).

A spectrum analyzer is a device used to display the spectrum of modulated waves in the radio frequency range and the microwave region. Communications and radar technicians are very interested in the harmonic make-up of signal. Proper interpretation of the displayed frequency spectrum enables you to determine if equipment is operating properly and the degree of the efficiency of the equipment being tested. For example, radio systems must be checked for harmonics of the carrier signal that might interfere with other systems operating at the same frequencies of the harmonics. Technicians also are interested in distortion of the message modulated onto the carrier. Third-order intermodulation (two tones of a complex signal modulating each other) can be especially troublesome because the distortion components can fall within the band of interest and not be filtered away properly. Examination of spectral occupancy is another important reason to use a spectrum analyzer. Modulation on a signal spreads its spectrum, and to prevent interference with adjacent signals, regulatory agencies restrict the spectral bandwidth of various transmissions.

Figure 6-15 is a simplified block diagram of a superheterodyne spectrum analyzer. *Heterodyne* means to mix or translate the frequency, and *super* refers to super-audio frequencies, or frequencies above the audio range. In the block diagram, the input signal passes through a low pass filter to a mixer, where it mixes with a signal from the local oscillator (LO). Because the mixer is a nonlinear device, its output includes not only the two original signals, but also their harmonics and the sums and differences of the original frequencies and their harmonics. If any of the mixed signals falls within the bandpass of the intermediate frequency (IF) filter, it is further processed, amplified, and then rectified by the detector. Following the detector, it is then applied to the vertical plates of the CRT to produce the vertical deflection on the CRT screen. The sawtooth generator deflects the CRT beam horizontally across the screen from left to right. The generator also tunes the LO so that its frequency changes in proportion to the ramp voltage of the sawtooth.

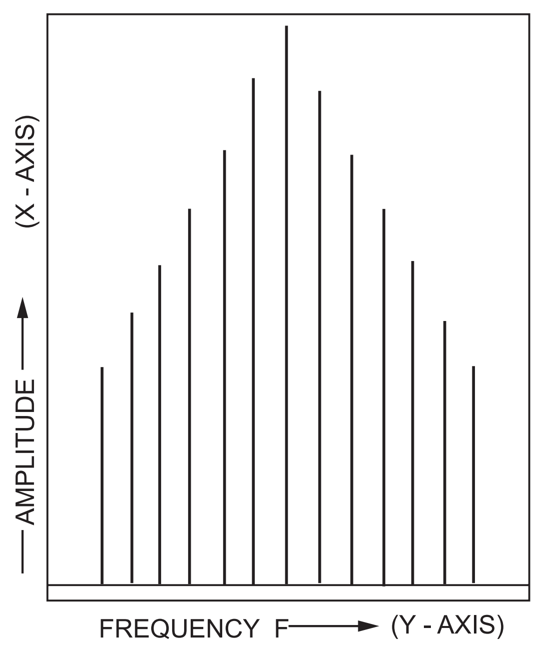

Figure 6-14.—Spectrum analyzer pattern.

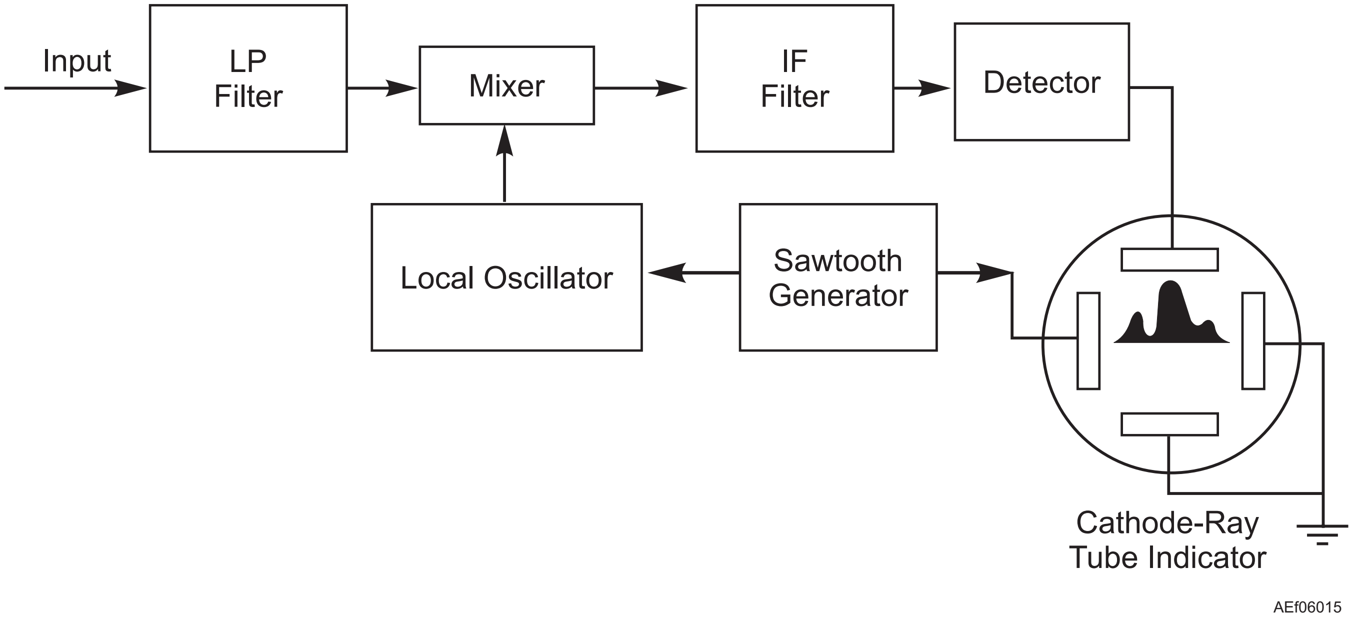

Figure 6-15.—Typical spectrum analyzer block diagram.

Model 8562A/B Portable Spectrum Analyzer

The 8562A/B (fig. 6-16) portable spectrum analyzer is a small, lightweight, self-contained instrument that needs only an external ac power source for operation. The instrument is very easy to use and makes quick and accurate measurements of signals from -119.9 dBm to + 30 dBm over a frequency range of 1 kHz to 22 GHz. The frequency range of the analyzer can be extended to 110 GHz by using HP 11970 series external harmonic mixers and to 325 GHz by using mixers from alternate manufacturers.

Basic functions of the unit include frequency, span, and amplitude. A menu-driven interface system makes the analyzer very easy to use. All measurements and settings are read directly from the CRT display with one-point measurement capability for quick results.

Figure 6-16.—Model 8562A/B spectrum analyzer.

Marker functions are available to determine frequencies and amplitudes along the spectrum analyzer trace that are used for making comparative measurements, automatically locate the highest amplitude signal on a trace, and automatically track a signal. A rear interface bus IEEE-488 allows full remote control operation of all analyzer functions and permits measurement results to be outputted to compatible test equipment and or computers.

Spectrum Analyzer Measuring Techniques

Most transmitting devices and signal sources contain harmonics. Measuring the harmonic content of such sources is frequently required. In fact, measuring harmonic distortion is one of the most common uses of a spectrum analyzer. Harmonic distortion can be checked quickly using the measurement routine described in table 6-15, which measures harmonic amplitudes relative to the source frequency. The harmonic distortion measurement uses many of the skills required to use a spectrum analyzer: setting the frequency, setting span by using start and stop frequencies, setting the video bandwidth, and making measurements by using the markers, to name a few. The next steps will pertain to measuring a 300 MHz fundamental frequency and its first two harmonics.

Another way of determining percent of distortion is by using the spectrum analyzer instead of the chart. This can be accomplished by changing the measured units to VOLTS by pressing AMPLITUDE and then from the menu selecting MORE, UNITS, and VOLTS. The marker readout will automatically switch to voltage units. Then by using the ratio given by the marker, move the decimal place two positions to the right.

For more information about spectrum analyzers and proper measuring techniques, refer to the manufacturer's publication supplied with the instrument being used.

Q6-43. What are the two axes of a typical spectrum analyzer?

Q6-44. What do the two axes represent?

Q6-45. What information does a spectrum analyzer exhibit?

Q6-46. What does the term heterodyne mean?

Q6-47. The signal being measured by a typical spectrum analyzer is applied to what plates of a CRT?

Q6-48. What is the power and frequency range of the 8562A/B spectrum analyzer?

Table 6-15.—Steps for Making Distortion Measurements

STEP	ACTION
1	Connect the unit to an ac power source and depress the line switch to turn on the spectrum analyzer. Then connect the signal source to the spectrum analyzer's INPUT 50 Ω connector and depress the PRESET button.
2	Set the start frequency to 270 MHz and stop frequency to 1000 MHz. This will allow the display of the 300 MHz fundamental frequency and the second and third harmonics. To improve the visibility, depress the BW switch which will access a menu of bandwidth functions, depress the VIDEO BW then select the STEP ↓ key as desired. (See fig. 6-17).
3	For improved measurement accuracy raise the peak of the fundamental to the reference level by pressing PEAK SEARCH, MKR→, and then MKR→REF LVL from the menu. (See fig. 6-18).
4	To measure the difference between the fundamental and the second harmonic, activate a second marker by pressing PEAK SEARCH, and then from the menu, depress MARKER DELTA and NEXT PEAK. This will place the second marker on the peak of the second harmonic, as shown in figure 6-18. The difference between the fundamental and second harmonic shown in the figure is approximately – 45 dB, or 0.56 % harmonic distortion by using the chart in figure 6-19.
5	To measure the third harmonic, press NEXT PEAK again from the menu. The marker should read approximately – 50 dB, or .32 % distortion by using the chart in figure 6-19.

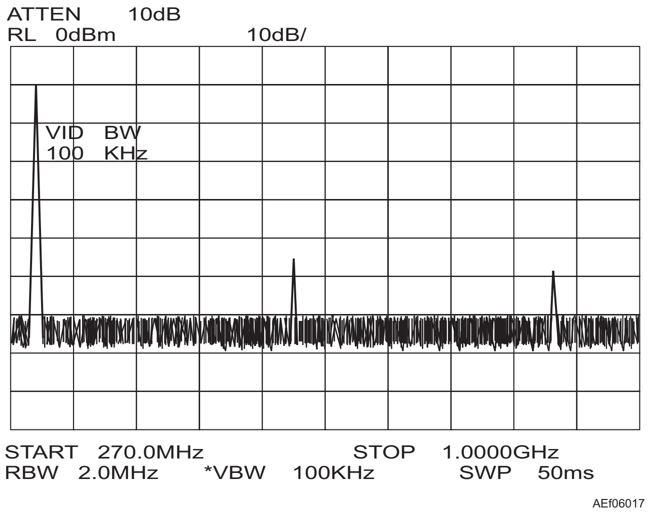

Figure 6-17.—300-MHz fundamental frequency and harmonics.

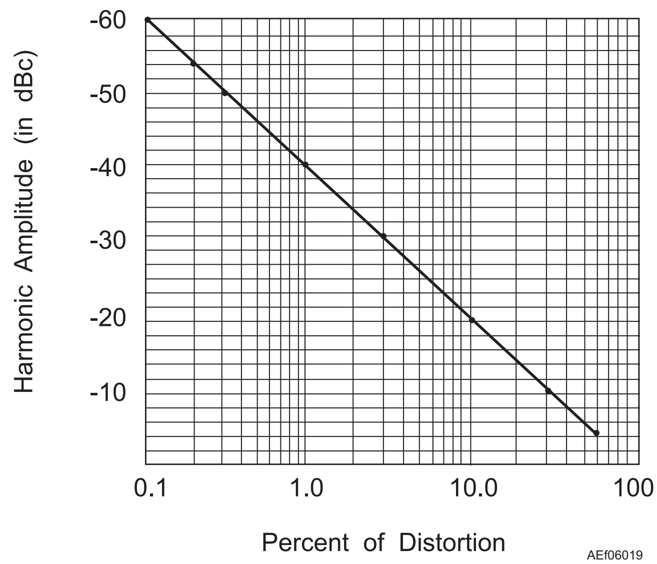

Figure 6-19.—Percent of distortion versus harmonic amplitude chart.

CONSOLIDATED AUTOMATED SUPPORT SYSTEM (CASS)

LEARNING OBJECTIVE: Identify general features and basic configurations of a typical Consolidated Automated Support System (CASS).

Automatic test equipment (ATE), such as the AN/USM-636A(V)1 Consolidated Automated Support System (CASS), the AN/USM-484 Hybrid Test System (HTS), the AN/USM-467 Radar Communications Tester (RADCOM), and the AN/USM-470 Tailored Mini Vast (TMV) are test equipment used aboard aircraft carriers and at shore installations. The use of computerized ATE or automatic test system (ATS) significantly reduces the space needed for special and manual support test equipment. As such computerized equipment, CASS will replace many different types of computerized ATE with one modern, cost-effective family of test equipment that increases repair capability and readiness. After ATE test benches from carriers and shore-based intermediate-level maintenance facilities are replaced, CASS will support a workload from the current and planned naval aviation inventory of aircraft to include the F/A-18 (all models), the EA-6B, the F-14 (all models), the H-60, the H-3, the E-2C, and the V-22.

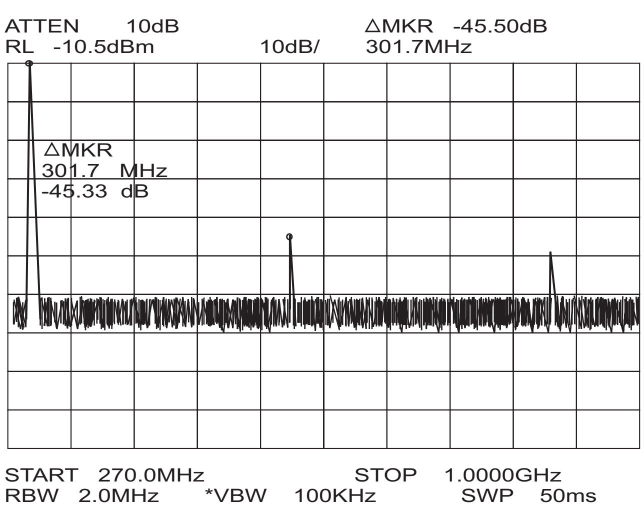

Figure 6-18.—Harmonic distortion of second harmonic measured in dB.

GENERAL DESCRIPTION

The CASS test station can test avionics systems whose technology encompasses frequency stimulus, frequency measurement, and digital functions. CASS capabilities include power conditioning, interface control, calibration, self-maintenance, instrumentation, and software to perform end-to-end tests, fault isolation tests, and alignment or adjustment of units under test (UUT). UUTs are interfaced to the test stations by test program sets (TPS), interface devices (ID), and accessories.

CASS CONFIGURATIONS

Since one test station capable of meeting all needs would be too large, CASS is modular. CASS test station modules are grouped in distinct configurations that are based upon the needs of the weapons system or systems that the test station supports.

There are four standard configurations of Navy CASS for intermediate- and depot-level testing. The CASS hybrid station, shown in figure 6-20, is the common core for the other three bench configurations—radio frequency, communication/navigation/identification friend or foe (CNI), and electro-optics (EO). The following descriptions summarize these configurations:

- Hybrid Station. The hybrid station is the general-purpose station for testing electrical/electronic equipment as well as computers, instruments, and flight control systems. Furthermore, the hybrid station can be used for testing pneumatics, displays, and inertial navigation systems.
- Radio Frequency Station. In addition to the capabilities of the hybrid station, the RF station has the capability to test electronic countermeasures (ECM), electronic counter countermeasures (ECCM), electronic warfare (EW), fire control radar, navigation radar, tracking radar, surveillance radar, and radar altimeters.
- Communication/Navigation/Identification Friend or Foe Station. In addition to the capabilities of the RF station, which includes the capabilities of the hybrid station, the CNI station can test communications, navigation, and spread spectrum systems.
- Electro-Optics Station. The CASS EO station has the basic test capabilities of the hybrid station plus the capability to test forward-looking infrared radar (FLIR), lasers/designators, laser range finders, and laser visual systems.

Q6-49. What does the acronym CASS stand for?

Q6-50. List three benefits of CASS.

Q6-51. What device connects a unit under test (UUT) to the CASS bench?

Q6-52. List the standard configurations of CASS benches.

Q6-53. What is the purpose of the CASS hybrid test station?

Q6-54. The CASS electro-optics station has the test capabilities of the hybrid station along with capabilities to test what additional equipment?

Figure 6-20.—CASS hybrid station.

CHAPTER 6

ANSWERS TO REVIEW QUESTIONS

A6-1. Calibration

A6-2. Work center 670

A6-3. The general rules for handling test equipment include:

1. *Use test equipment properly and only for its designed purpose.*
2. *Select the proper range for the measured quantity.*
3. *Protect the equipment from physical harm that may result from dropping, falling, or other misuse.*
4. *Store test equipment in a clean, dry place with dust covers attached. (This reduces the chances of corrosion and water intrusion).*
5. *Use the test equipment instruction manual.*

A6-4. Nonsinusoidal signals

A6-5. The frequency response of the meter being used

A6-6. Across the load or power source (in parallel with the circuit)

A6-7. Greater than 1Ω

A6-8. Off

A6-9. In series with circuit being measured thus allowing all the circuit current to flow through the meter circuitry

A6-10. The closed position

A6-11. To measure the current leakage of the insulation by providing a high voltage to a component under test

A6-12. Capacitors, insulated cables, antennas, insulators, and high-resistance ground components

A6-13. A generator and an indicating meter

A6-14. About 0 ohms

A6-15. The equipment should be grounded or shorted

A6-16. The MJ10 generates voltage with a hand-driven generator and the BM12 uses a generator driven by six 1.5-Vdc batteries

A6-17. 46 GHz

A6-18. Period, ratio, time interval, time interval delay, interval average, and totalize

A6-19. The internal crystal oscillator (oven oscillator) or time base

A6-20. By keeping the counter connected to power

A6-21. The conventional counter and reciprocal counter

A6-22. The reciprocal type counter always makes period measurements of the input signal and then takes the reciprocal of that measurement if a frequency *measurement is required whereas the conventional type counter measures the input signal by counting the number of cycles and dividing it by the time interval.*

A6-23. 1.3 GHz

A6-24. Measurement of harmonically related signals

A6-25. The power meter

A6-26. Thermocouples, diodes, and thermistors

A6-27. For sensitivity as well as low-noise and drift characteristics

A6-28. 100 kHz to 110 GHz, depending on the model of sensor used

A6-29. To let a technician analyze electrical and electronic signals when the technician troubleshoots or aligns electrical and electronic equipment

A6-30. The X-, Y-, and Z-axes

A6-31. X-axis represents time, Y-axis represents amplitude, and the Z-axis represents the intensity or brightness of the signal

A6-32. An oscilloscope can provide the following items of information:

- *The time of a signal*
- *The voltage of a signal*
- *The frequency of a signal*
- *How often a particular portion of a signal is occurring relative to other portions*
- *If a malfunctioning component is distorting a signal*
- *How much of a signal is made of noise*
- *If noise is changing with time*
- *How much the signal is made up of ac*
- *How much the signal is made up of dc*

A6-33. Analog and digital

A6-34. The display on the CRT becomes dim and very hard to see.

A6-35. Analog, digitizing, and digital phosphor

A6-36. The sample rate

A6-37. The scope can display electrical events that may happen only once.

A6-38. VOLT/DIV control

A6-39. Trigger level control

A6-40. Digitizing storage oscilloscope

A6-41. False. The signal should cover the screen vertically.

A6-42. True

A6-43. The X- and Y-axis

A6-44. X-axis represents amplitude, and Y-axis represents frequency

A6-45. The spectrum of modulated waves in the radio frequency range and microwave region

A6-46. To mix or translate a frequency

A6-47. The vertical plates of the CRT

A6-48. –119.9 dBm to + 30 dBm and 1 kHz to 22 GHz, respectively

A6-49. Consolidated Automated Support System

A6-50. Benefits of CASS include the following:

- *Increases repair capabilities*
- *Increases material readiness*
- *Reduces the physical space required for electronic testing equipment*

A6-51. A test program set (TPS), an interface device, or an accessory

A6-52. Standard configurations are the following:

- *Hybrid*
- *Radio frequency (RF)*
- *Communication/navigation/identification friend or foe (CNI)*
- *Electro-optics (EO)*

A6-53. To be a general-purpose test station for the testing of electrical and electronic equipment as well as computers, instruments, and flight control systems

A6-54. Forward-looking infrared radar (FLIR), lasers/designators, laser range finders, and laser visual systems